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Wednesday, March 21, 2007

The trouble with science

Science has revolutionized life since at least the age of exploration, through the industrial revolution, and to an unprecedented degree in the 20th century. Science generally, and physics in particular, got a vast boost in credibility and in government funding following the ability of physicists to develop weapons of unprecedented power in the Manhattan Project. Scientists and their engineering brethren also developed modern electronics, sent men and machines into the cosmos, and much else that would have seemed like miracles and prophecy in prior centuries. Sciences such as psychology and evolutionary theories of behavior have at least potentially revolutionaized our understanding of ourselves. Now we have a large number of self-styled "social sciences" that attempt to understand social behavior and societies through scientific methods. Instead of priests prophecying and invoking miraculous thunderbolts through mumbo-jumbo, our modern scientific priesthood helps create real technology and tells us what to think about social systems and political options by what seems to most people (and even to most scientists outside the particular specialty in question) equally mystical mumbo-jumbo.

This scientific elite is supposed to be all quite different from the priesthoods of old because it is supposed to adhere to scientific methods rather than superstition and dogma. The scientific method developed from several sources, but one that is particularly interesting is the law of evidence in medieval and Renaissance Continental Europe. In English law, issues of fact were (and are) determined by a jury and the law of evidence is all about the general biases of juries and thus what lawyers are and are not allowed to present as evidence to them -- the basic rule to overcome juror bias being that the relevance and integrity of the information must outweigh its potential to prejudice the jurors. But in the neo-Roman law that dominated the Continent from the Late Middle Ages to this day, juries were rare and judges determined issues of fact as well as law. Thus there developed in Continental law elaborate doctrines about how judges were supposed to weigh factual evidence.

Many Renaissance and Baroque era scientists, such as Galileo, Liebniz, and Pascal, had legal training and this Continental law of evidence was reflected in their methods. Most other early scientists had been exposed to law-derived doctrines simply by attending universities many of whose doctrines derived from the original universities which were essentially law schools. Soon, however, the scientific community was independently evolving its own cultural norms from this starting point. The ideal was to seek the truth. Experiment became the *sine quo non* of scientific credibility, along with mathmetical rigor and important applications in navigation, engineering, and medicine. Scientific funding came from a variety of sources; when governments funded scientists they were expected to solve important problems such as those raised by navigation of the seas, not merely to theorize. After the Englightenment governments started to separate themselves from the social dogmas of their day -- religions -- by making secularizing government and allowing freedom of religion.

Today a wide variety of important political issues are dominated by ideas from scienitific communities (or at least communities that

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Nick Szabo

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style themselves as scientific): economists, climate scientists, and many others. But there is no separation of science from government. Like the state-sponsored religions of yore, most modern scientists derive both their education and their ongoing livelihood from government funding of the theories with which they are taught and on which they work.

The old state-sponsored religions, and the resulting ideas about politics and society, were funded by governments. Not surprisingly, as such governments took over religion it became sacreligious to criticize the importance of government generally and often specific governmental institutions in particular. Under the nationalizers of dogma such as Henry VIII, who nationalized the lands and priests of the Catholic Church in England, "render under Caeasar" became more important than "render under God." Despite the advantages of better funding these state-sponsored sects have been in decline ever since governments stopped otherwise suppressing their competitors. The state sponsored churches mostly taught uncritical worship of authority whereas their private competitors added much more spiritual value to their adherent's lives.

The simplest science is physics. In some sense all other sciences are just a variety of complex models of what happens when various kinds of complex physical systems interact. Physics itself is the simple core of science. Thus physics has been hailed as the "hardest" of the "hard sciences" -- sciences where evidence trumps bias and the truth always outs sooner or later, usually sooner, despite the biases of the individuals or institutions involved. Hard scientists will often admit that the use of the scientific method in "soft sciences" such as economics and other intersubjective areas can be problematic and subject to great bias. If any science can rise above self-serving biases and efficiently search for the truth, it should be physics.

But the recent history of physics casts some rather disturbing shadows on the integrity of even this hardest of sciences. Lee Smolin in *The Trouble with Physics* lays out a picture of an unprecedented group of geniuses, the string theorists, who have wasted the last twenty years, largely at taxpayer's expense, basically producing nothing except a vast number of highly obscure but, in certain senses, quite elegant theories. The number of possible string theories is so vast that string theory can, like "intelligent design," explain anything -- it is unfalsifiable. It is "not even wrong," to take Wolfgang Pauli's phrase about an earlier unfalsifiable theory of his era. String theory's main rivals over the last two decades are not much better. Theoretical physics for the last twenty years has mostly not been science at all, but rather has been a large group of geniuses working on their own cabalistic variety of sudoku puzzles at taxpayer expense in the name of science.

If this is the state of physics -- if even the hardest of sciences can be taken over by a thousand-strong cabal of geniuses who produce nothing of value except wonderful-sounding untestable theories whose main success has been in garnering their community more of our tax dollars -- what hope do we have that government-funded climate scientists, economists, and others purporting to do science in areas far more complex or subjective than physics are actually producing relatively unbiased truths? If we took a poll of theoretical physicists, they might well have (up until quite recently) reached a remarkable degree of "consensus" on the truth of string theory -- just as global warming scientists have reached a "consensus" on global warming and (it is implied) on the various bits of the speculative nonsense surrounding global warming. Does such consensus mean us lay people should automatically believe this consensus of experts? Or should we demand more? Shouldn't we rather, when deciding on which theories or predictions of climate science or economics to believe, act like a Continental judge or a common-law jury and demand to actually see the evidence and weigh it for ourselves? Shouldn't we demand to hear from the defense as well as from the prosecution? Experiment, multiple points of view, and critical analysis are, after all, the real scientific method -- as opposed to the ancient religious method of uncritically trusting a single hierarchy of experts.

Today's ideas about politics and society -- "scientific theories" if you agree with them, "dogmas" if you don't -- are funded by the very governmental entities that stand to benefit from increased government power. Just as it was taboo under Henry VIII to "deny" the authority of either Christ or the King, it has now become taboo in many of these modern intellectual communities to "deny" a variety of scientific theories that are now supposed to be "beyond debate," not just things like the basic idea of global warming caused at least in part by anthropogenic carbon dioxide(which this author finds sound and quite probable, but nevertheless believes should remain like all true scientific theories open to further inquiry and debate) but also the variety of extreme speculations that have grown up around

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it (regarding the severity of storms, projections of droughts, floods, etc., most of which are pseudoscientific nonsense).

I'm hardly the only person who recognizes this problem with science. Indeed, the opinion expressed above is quite mild compared to an increasing number of conservatives who are coming to reject big chunks of good science along with the bad -- not just the many florid speculations surrounding global warming, but global warming itself, evolution, and other products of the expert priesthood that threaten long-established (and often, ironically, highly evolved) beliefs. Conservatives, and more than a few libertarians, feel that modern science is becoming increasingly dominated by government funding and thus becoming dominated by the interests of government in gaining more dominance over our lives. With opposing ideas increasingly unable to access to this research and education funding themselves, the easiest way for those opposed to increasing state power to effectuate their beliefs is to reject the theories of the scientific communities that promote this power.

This, and not sheer cave-man irrationality, is why many conservatives are increasingly throwing out the baby with the bathwater and rejecting science generally. Both trends -- the increased government dominance over science and the increasing rejection of science generally by those who oppose increased government controls which scientists increasingly promote -- are disturbing and dangerous. Science, once a method of weighing evidence that called for the opinions of both prosecution and defense, is increangly being dominated by the prosecution.

We need a return to science with a diversity of funding and thus a diversity of biases. This is much more important to the health of science than the absolute level of funding of science. Reducing government funding of science would thus *increase* the quality of science -- by making the biases of scientific communities more balanced and thus more likely to cancel each other out, just as the biases of the defense generally cancel out the biases of the prosecution. Where government does fund science, it should demand strict compliance to the basic evidentiary principles of science, such as falsifiability. All government-funded theorists should be required to design experiments that can be conducted relatively inexpensively and in the near future, that would strongly tend to verify or falsify their proposed theories. More speculative theories -- such as those that rely on unobserved or worse, unobservable entities -- simply should not be funded by governments. There are a wide variety of private entities that are happy to fund such speculations; this variety of funding sources is more important to reducing bias the further one gets away from strictly controlled experiment. Any time government funds science we should ask, does the utility of the potential discoveries and the integrity of the scientific methods being used -- their ability to find the truth even in the face of high institutional bias -- outweigh the potential for the funding by one dominant source to prejudice the opinions of the fund recipients?

Science has benefited our lives in incalculable ways for many centuries. Increasingly we inform our political decisions with the discoveries and theories of science. As sciences ranging from climatology to economics play an increasing role modern politics, this task of building a wall of separation between government and science -- or at least not allowing states to sponsor particular scientific theories at the expense of others with comparable weights of evidence, and not allowing states to fund some biased speculations at the expense of others -- is one of our most important and urgent tasks. If we are to remain living in democracies we voters must learn once again to weigh some of the evidence for ourselves, even if this means we gain our understanding through the lossy communications of popularizers. It does not work to trust a theory, no matter how scientific it may sound, based on a "consensus" or "lack of debate" among experts who mostly derive their funding from a single biased source. We democratic jurors must demand to hear from the defense -- really from a variety of parties whose biases largely cancel each other out -- rather than from just the prosection. We must redesign our scientific institutions to minimize the biases that come from a single dominant source of funding if we are to achieve good solutions to our important problems -- solutions that are not dominated by the biases of that dominant entity.

Posted by Nick Szabo at 9:50 PM

7 comments:

David M. Cooke said...

I agree that the string theorists have probably strayed too far from "testable" path. However, they are only a small minority -- there are many more theoretical physicists working in condensed matter than in string theory. In my department, there are 8 theorists on the faculty, of which only one is a string theorist. (I'm not counting the astrophysicists or cosmologists, as they tend to get huffy when you do that.) Most of them are working in condensed matter. The distribution of graduate students is even more one-sided. The American Physical Society's March meeting, which is mostly condensed matter, this year ran 44 sessions in parallel, four times a day, for a week. The April meeting (pretty much everything else in physics) will run about 16 sessions in parallel. (And the PDF for the conference program is about 7 times larger for the March meeting.) Condensed matter is, of course, not as sexy as string theory.

In terms of funding, who would fund these kinds of endeavours? For some things, there are funds available from industry, as there obvious short-term applications. However, a good portion is just basic physics, which may (or may not) have applications 50 years down the road. These long-term projects with unpredictable results are not usually interesting to industry with short-term goals in mind.

Also, theorists are relatively cheap: give them money for some computers, a few graduate students and postdocs, and they're mostly happy. Compare this to experimental physics, for which they need the preceding, but also expensive equipment and materials (huge particle accelerators, neutron beamlines, NMR machines, technicians to run things, to name a few).

I agree that scientists working for the government should be more separated, and less susceptible to political pressure. Those are the ones that make the news, though: scientists working in universities aren't prone to the same type of interference.

4:07 AM

mtraven said...

This is written as if there was just one monolithic entity in the world called "The Government". In fact, there are multiple governments funding science (mainly in Europe and Japan), and within the US government there are multiple funding agencies with their own priorities. Don't know about physics, but in biology you have funding from NSF, NIH, NIST, DOE, and probably others.

Private funding of research comes when it's in their own interest, or when the industry has a near monopoly and can afford to act like a government (the old Bell Labs, the old IBM, the current Google). Or when some private individual amaasses enough surplus that they can be a major charity (The Bill Gates Foundation). That's all very well but not likely to compete with the government any time soon. Nor should it, IMO -- private concentrations of wealth that are that large make me more nervous than the government.

11:34 AM

Nick Szabo said...

David Cooke -- thanks for the clarification. I was using "theoretical physics" in the sense Smolin was using it; a better phrase may be "fundamental theoretical physics" to distinguish it from other kinds like the condensed matter physics you discuss.

mtaven, the different government programs provide a very limited variety. They all come with a very consistent bias -- they all have an incentive to increase their revenue by exagerating problems, an incentive that is unmitigated by market forces. And why do you say that "private concentrations of wealth that are that large make me more nervous than the government"? Historically, governments have imprisoned, killed, and otherwise destroyed the lives of far more people than the greediest of corporations. Where governments have controlled science they have abused it in a wide variety of ways, ranging from turning science into state-sponsored dogma (e.g. Lysenkoism)to the racial theories of National Socialist Germany and the subsequent concentration camps, genocide, and grotesque experiments on unwilling victims. I am not aware of any similar abuses by a corporation. Under modern laws private entities can get away with far fewer abuses than can governments, and competition mediated by a vast market is a strong force for balancing and

cancelling out biases which is largely absent from the D.C. insider culture and hierachical scientific elite that largely determines scientific funding

12:22 PM

mtraven said...

Let me pass on the "which is more dangerous" issue, since you may be right and in any case it threatens to turn into a standard boring argument.

The point I really wanted to make is this: funding pure scientific research requires serious surplus capital, since science is not something that has a short term economic payoff. Pure science is a) risky, b) has a long time horizon, c) even if successful might not have any concrete economic impact, and d) whaever economic good it produces is not ownable. So, the only entities that can afford to fund long-term pure science are a) governments, b) rich private individuals or charities, or c) monopolies. The product of science is a classic public good and its production is not readily privatized. Monopolies are freed from the constraints of competition and so can afford to invest in things that may not pay off and in any case can't be owned.

Thus, any corporation that could afford to fund a group of theoretical physicists is probably a monopoly or near-monopoly already (and the casees that I can think of where private firms have done serious basic physics research, AT&T and IBM, fit that mold).

The institutional problems you bring up with big science may be real, but that doesn't mean that a science driven by market forces will be better. In fact, I can't see how it could work at all, and I'd say the burden of proof is on you.

You'll also need to make a much better case that government funding is somehow stultifying multiple points of view. As far as I know, both string-theorists and anti-string-theorists can get government grants. Also I think your dismissal of diversity in government funding sources is too glib. Yes, everybody is biased towards inflating their own self-importance -- the scientists and funding agencies both. That's a human universal. But that's not the problem you are addressing. The only real problem i see in the sort of hierarchical meritocracies that rule science is that it's possible for an orthodoxy to capture the sources of funding and prevent heterodox opinions from being developed. Undoubtadly this happens sometimes, maybe even frequently. But a diversity of funding agencies mitigates against it.

9:18 PM

Jeremy said...

Market based science in the current corporate climate wouldn't actually be too terribly different from government dominated science. But I don't think that's the point Nick is making. He's saying the incentives are messed up when science is done institutionally.

Look at the great theorists and experimenters of science's infancy. None of them ran huge research labs, and most weren't even full-time scientists. But the discoveries they made lasted because they had a personal passion for the process of scientific inquiry. They were also more inclined to do "pure science" than research as tribute to centralized institutions with an agenda.

This idea that science can only be done by large scale institutions and multi-million dollar budgets assumes that the interests that motivate science (and, for that matter, "progress" in general) are fixed. They are not. As Lewis Mumford has argued, technological progress can occur in a variety of ways depending on what the needs to society are.

So: if we have a bunch of big players in the game - privileged, outsized corporations, governments, bloated educational institutions - who all press for the kind of science that's done to promote their agenda, we miss out on science done according to a smaller scale, decentralized agenda pursued by a wide variety of researchers. Government / corporate funding doesn't just corrupt science - it moves science in a different direction than even scientists might otherwise pursue. The implications, especially with regard to intellectual property and military applications, should be obvious.

Even now there are alternatives, such as wiki-science and amateur research. If those concepts have disadvantages, we should not ignore their inherent advantages. Most of all, we should not treat them as less scientific - science is largely a process disconnected for particular priorities, and there's no reason we can't have a market in those priorities.

8:39 AM

Anonymous said...

Nick,

I suspect you've already found Climate Audit, but if it not it may, um, sharpen your perception of the problem...

2:00 PM

Anonymous said...

If anything, government-sponsored research, particularly in things like physics, is going to have to *increase* if further progress is going to be made. What corporation, or group of corporations, would fund the Large Hadron Collider? Its construction costs are in the billions. None of the work has any useful application in any corporate reasonable time horizon. The next collider will cost even more. Without these colliders, important chunks of theoretical physics can't get any experimental confirmation.

But let's put this aside, as you might think that we ought to spend less on high-energy physics and more on cheaper science. Surely some of it is such that research divisions of various corporations would have some interests in contributing to the research, either with money to universities or with their own efforts. However, it should be noted that a great deal of such science has zero use value for a majority of corporations. Who will fund that work? Or how about just the very low-probability work?

It is also notable that, in the Modern era, there have been two main locations for a great deal of scientific work (and particularly in Physics). First, Germany and Austria. Most of the Quantum Revolution came from people that worked through the German educational system and had German funding. This is in contrast to the lots of smart English folks who were all "gentleman scientists" as there was no funding agencies at the time - science was largely a rich man's hobby. Not surprisingly, Germans accomplished a lot more. After WWII, the power in science has been the United States. This is undoubtedly due to the fact that many national science funding sources were established. In fact, it is not difficult to make the argument that our current economic success is in large part due to the huge basic research subsidy provided by the US Government, which allowed thousands of companies to thrive. As we were undoubtedly more laissez-faire as a country prior to FDR, we should have seen a significant drop in innovation. But we see precisely the opposite. More government funding, more good science.

Of course, the relevant question to ask is, if corporations and scientists in some sense share the interest of having more diversity of funding sources, because this would lead to higher-quality science, why has this not already happened? There is nothing prohibiting any organization from providing scientific funding. And no doubt, scientists would accept more money. So if this is the more efficient solution, why hasn't the market already moved to it?

4:55 PM

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